MULTIMEDIA UNIVERSITY

STUDENT ID NO

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 1, 2022/2023 (TERM ID 2215)**

## EME1016 – APPLIED STATICS

(ME)

15 FEBRUARY 2023
2:30 p.m. – 4:30 p.m.
2 Hours

---

**INSTRUCTIONS TO STUDENTS**

1. This Question paper consists of 9 pages including cover page with 5 Questions and 3 appendices.

2. Attempt **FOUR** out of **FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

## Question 1

(a) Three chains act on the bracket such that they create a resultant force having a magnitude of 500 N. If two of the chains are subjected to known forces, as shown in Figure Q1(a), determine the angle $\theta$ of the third chain measured clockwise from the positive $x$ axis, so that the magnitude of force **F** in this chain is a minimum. All forces lie in the $x$-$y$ plane. What is the magnitude of **F**?

**[12 marks]**

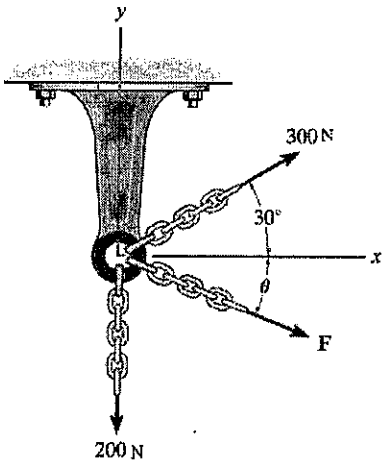



Figure Q1(a)

(b) If the tension developed in each of the wires is not allowed to exceed 40 N, determine the maximum weight of the flowerpot shown in Figure Q1(b) that can be safely supported.

**[13 marks]**

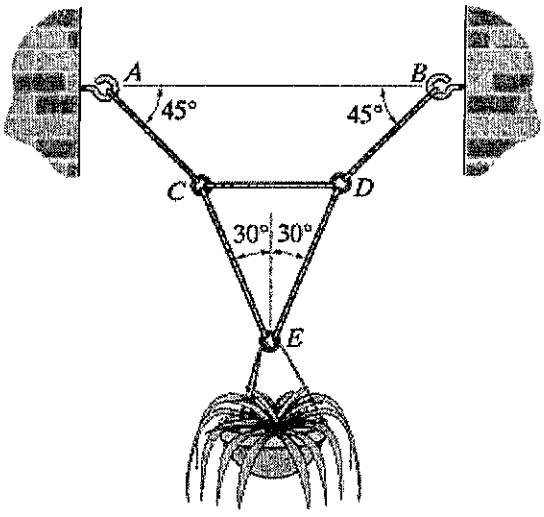



Figure Q1(b)

**Continued .....**

## Question 2

(a) As shown in Figure Q2(a), a force of 80 N acts on the handle of the paper cutter at $A$. Determine the moment created by this force about the hinge at $O$, if $\theta = 60^0$. At what angle $\theta$ should the force be applied so that the moment it creates about point $O$ is a maximum (clockwise)? What is this maximum moment?

**[12 marks]**

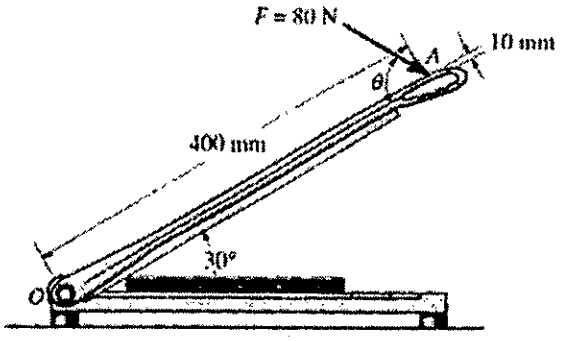



Figure Q2(a)

(b) As shown in Figure Q2(b), the member $ABC$ which is supported by a smooth collar at $A$, roller at $B$, and short link $CD$. Draw the free-body diagram of the member and then determine the reactions on the member at $A$, $B$, and $C$.

**[13 marks]**

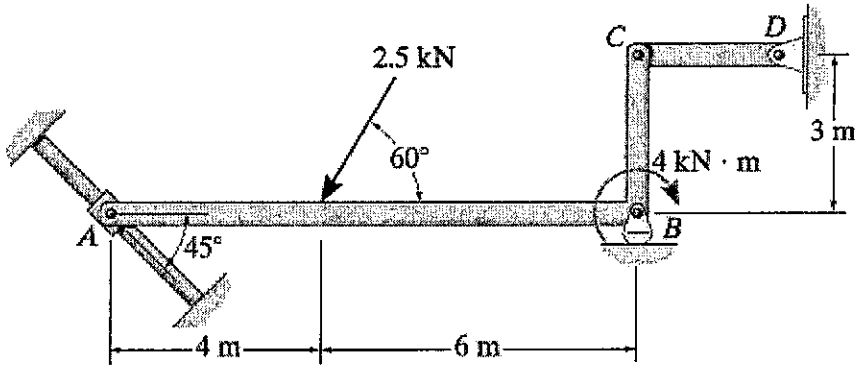



Figure Q2(b)

**Continued .....**

**Question 3**

(a) Determine the force in members *CD* and *GF* of the truss shown in Figure Q3(a) and state if the members are in tension or compression. Also indicate all zero-force members.

**[12 marks]**

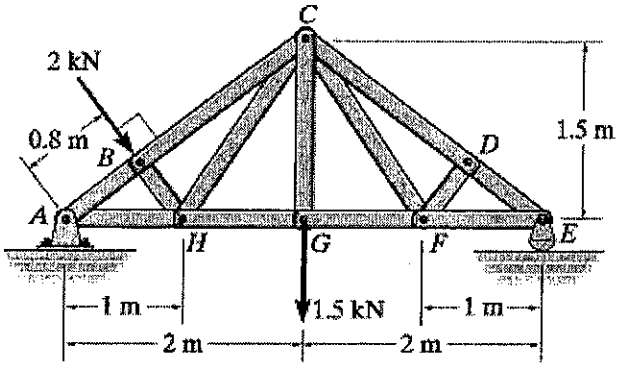



Figure Q3(a)

(b) For the frame shown in Figure Q3(b), if the peg at *B* is smooth, determine the components of reaction at the pin *A* and fixed support *C*.

**[13 marks]**

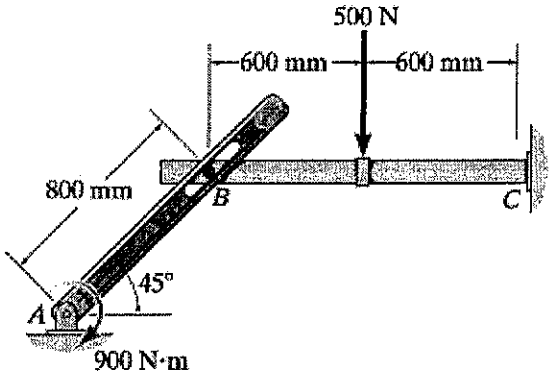



Figure Q3(b)

**Continued .....**

## Question 4

(a) As shown in Figure Q4(a), the lifting beam is used for materials handling. If the suspended load has a weight of 2 kN and a center of gravity of $G$, determine the placement $d$ of the pad eyes on the top of the beam so that there is no moment developed within the length $AB$ of the beam. The lifting bridle has two legs that are positioned at 45°, as shown.

**[13 marks]**

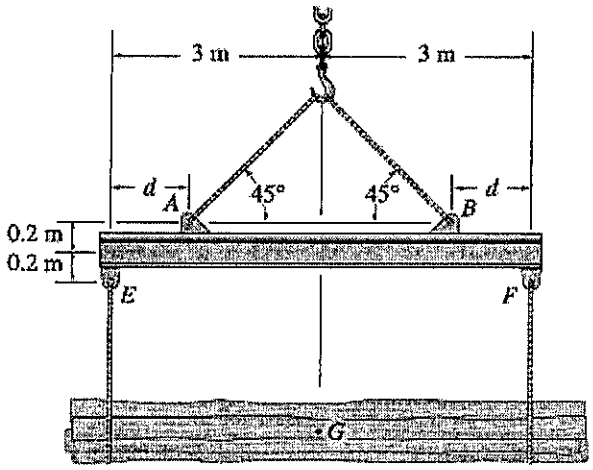



Figure Q4(a)

(b) Determine the volume and locate the centroid $(\overline{y}, \overline{z})$ of the homogeneous conical wedge shown in Figure Q4(b).

**[12 marks]**

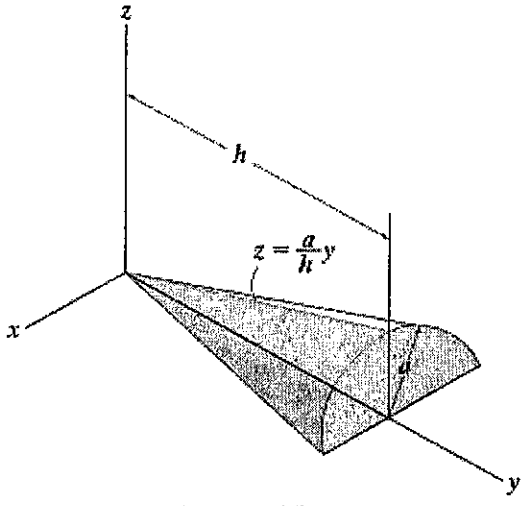



Figure Q4(b)

**Continued .....**

## Question 5

(a) As shown in Figure Q5(a), the uniform dresser has a weight of 90 N and rests on a tile floor for which $\mu_s = 0.25$. If the man pushes on it in the horizontal direction $\theta = 30^0$, determine the smallest magnitude of force **F** needed to move the dresser. Also, if the man has a weight of 150 N, determine the smallest coefficient of static friction between his shoes and the floor so that he does not slip.

**[13 marks]**

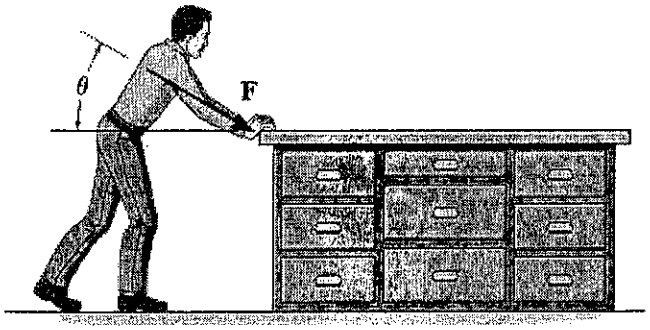



Figure Q5(a)

(b) If the beam $AD$ is loaded as shown in Figure Q5(b), determine the horizontal force **P** which must be applied to the wedge in order to remove it from under the beam. The coefficients of static friction at the wedge's top and bottom surfaces are $\mu_{CA} = 0.25$ and $\mu_{CB} = 0.35$, respectively. If $P$ = 0, is the wedge self-locking? Neglect the weight and size of the wedge and the thickness of the beam.

**[12 marks]**

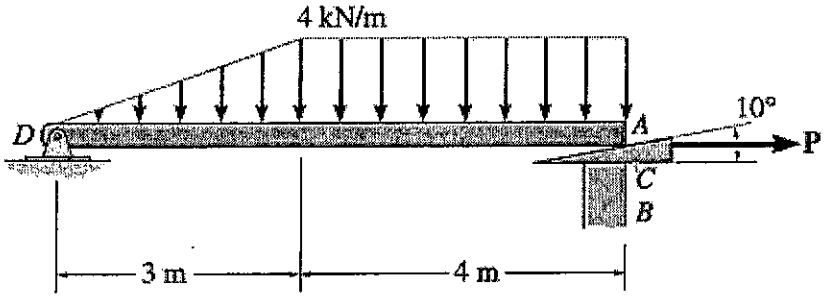



Figure Q5(b)

**Continued .....**

## Appendix 1

## Fundamental Equations of Statics

**Cartesian Vector**

$$\mathbf{A} = A_x\mathbf{i} + A_y\mathbf{j} + A_z\mathbf{k}$$

*Magnitude*

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

*Directions*

$$\mathbf{u}_A = \frac{\mathbf{A}}{A} = \frac{A_x}{A}\mathbf{i} + \frac{A_y}{A}\mathbf{j} + \frac{A_z}{A}\mathbf{k}$$
$$= \cos\alpha\mathbf{i} + \cos\beta\mathbf{j} + \cos\gamma\mathbf{k}$$
$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$$

**Dot Product**

$$\mathbf{A}\cdot\mathbf{B} = AB\cos\theta$$
$$= A_xB_x + A_yB_y + A_zB_z$$

**Cross Product**

$$\mathbf{C} = \mathbf{A}\times\mathbf{B} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

**Cartesian Position Vector**

$$\mathbf{r} = (x_2 - x_1)\mathbf{i} + (y_2 - y_1)\mathbf{j} + (z_2 - z_1)\mathbf{k}$$

**Cartesian Force Vector**

$$\mathbf{F} = F\mathbf{u} = F\left(\frac{\mathbf{r}}{r}\right)$$

**Moment of a Force**

$$M_o = Fd$$
$$\mathbf{M}_o = \mathbf{r}\times\mathbf{F} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

**Moment of a Force About a Specified Axis**

$$M_a = \mathbf{u}\cdot\mathbf{r}\times\mathbf{F} = \begin{vmatrix} u_x & u_y & u_z \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

**Simplification of a Force and Couple System**

$$\mathbf{F}_R = \Sigma\mathbf{F}$$
$$(\mathbf{M}_R)_O = \Sigma\mathbf{M} + \Sigma\mathbf{M}_O$$

**Equilibrium**

*Particle*

$$\Sigma F_x = 0, \Sigma F_y = 0, \Sigma F_z = 0$$

*Rigid Body-Two Dimensions*

$$\Sigma F_x = 0, \Sigma F_y = 0, \Sigma M_O = 0$$

*Rigid Body-Three Dimensions*

$$\Sigma F_x = 0, \Sigma F_y = 0, \Sigma F_z = 0$$
$$\Sigma M_x = 0, \Sigma M_y = 0, \Sigma M_z = 0$$

**Friction**

*Static (maximum)* $F_s = \mu_s N$

*Kinetic* $F_k = \mu_k N$

**Center of Gravity**

*Particles or Discrete Parts*

$$\bar{r} = \frac{\Sigma\tilde{r}W}{\Sigma W}$$

*Body*

$$\bar{r} = \frac{\int\tilde{r}\,dW}{\int dW}$$

**Area and Mass Moments of Inertia**

$$I = \int r^2\,dA \qquad I = \int r^2\,dm$$

*Parallel-Axis Theorem*

$$I = \bar{I} + Ad^2 \qquad I = \bar{I} + md^2$$

*Radius of Gyration*

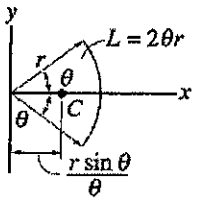
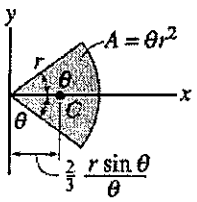
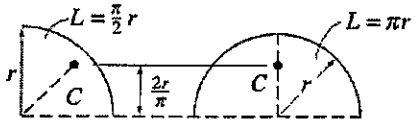
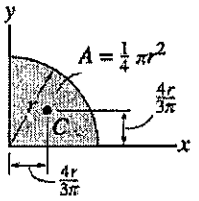
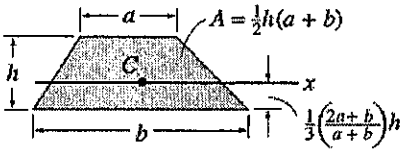
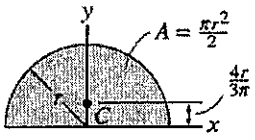
$$k = \sqrt{\frac{I}{A}} \qquad k = \sqrt{\frac{I}{m}}$$

**Virtual Work**

$$\delta U = 0$$

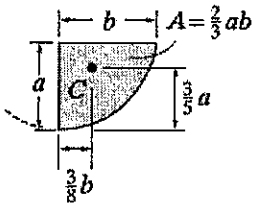
Continued .....

## Appendix 2: Geometric Properties of Lines and Area Elements

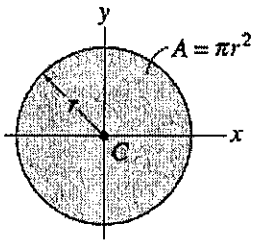
| Centroid Location | Centroid Location | Area Moment of Inertia |
|---|---|---|
|  Circular arc segment |  Circular sector area | $I_x = \frac{1}{4}r^4(\theta - \frac{1}{2}\sin 2)\theta$<br>$I_y = \frac{1}{4}r^4(\theta + \frac{1}{2}\sin 2)\theta$ |
|  Quarter and semicircle arcs |  Quarter circle area | $I_x = \frac{1}{16}\pi r^4$<br>$I_y = \frac{1}{16}\pi r^4$ |
|  Trapezoidal area |  Semicircular area | $I_x = \frac{1}{8}\pi r^4$<br>$I_y = \frac{1}{8}\pi r^4$ |

**Continued .....**

## Appendix 3: Geometric Properties of Lines and Area Elements



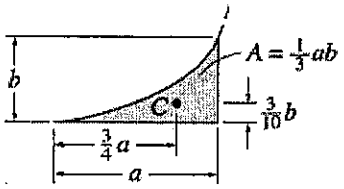

Semiparabolic area



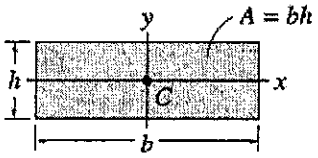

Circular area

$I_x = \frac{1}{4}\pi r^4$

$I_y = \frac{1}{4}\pi r^4$



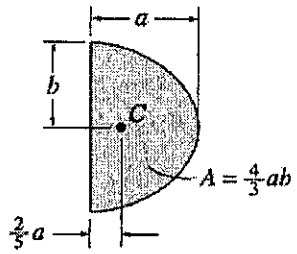

Exparabolic area



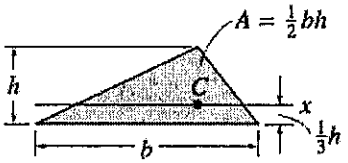

Rectangular area

$I_x = \frac{1}{12}bh^3$

$I_y = \frac{1}{12}hb^3$




Parabolic area




Triangular area

$I_x = \frac{1}{36}bh^3$

**End of Paper**